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ABSTRACT

This study investigates whole-school and district efforts to change mathematics and science instruction at their sites during the first year of reform. Two middle schools, one high school, and one elementary school participated in this study. The Model Schools Program which is utilized in this study features a constructivist approach. Teams of teachers and administrators from participating schools design and implement their own mathematics and science reform plans with assistance from university faculty, acting as coaches for the school teams. Findings indicate that significant change can take place in classroom teaching practices through teacher-led reform, and the professional development must be held within a collaborative context using university faculty as coaches, team members, and stakeholders in the reform. (KHR)

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The Wright State Model School Initiative: A Summary of Efforts Made to Scale up Reform in Mathematics and Science Education during Year One

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THE WRIGHT STATE MODEL SCHOOL INITIATIVE: A SUMMARY OF EFFORTS MADE TO SCALE UP REFORM IN MATHEMATICS AND SCIENCE EDUCATION DURING YEAR ONE

Purpose of Study

In this study, quantitative and qualitative methods are used to investigate whole-school and district efforts to change mathematics and science instructions at their sites during the first year of reform. The findings from this study will enrich the existing knowledge base of school-based and school-wide change. These findings will also help track the success of mathematics and science reform efforts initiated by Ohio's Systemic Initiative, *Discovery*.

Significance of Study

In 1994 Title I funds were authorized to fund whole school reform efforts that enabled high-poverty schools to use the money for school-wide projects rather than targeted assistance. In addition, the Comprehensive School Reform Demonstration (CSRD) Program in U.S. Congress (1997), has contributed $150 million dollars to schools willing to adopt research-based reform programs. This initiative instigated further use of pre-established and tested reform designs. As of July 2000, CSRD has funded reform efforts in over 1,800 schools. Individual schools received grants of up to $50,000 for reforms through CSRD programs (Datnow, 2000).

Most of the research base on whole-school reforms focus on reform designs created and implemented by external teams in the form of prepackaged curriculum and instructional models (Springfield et al., 1997; Slavin and Fashola, 1998; Herman et.al. 1999; Stanow, 2000). This has provided very little control and input for teachers and stakeholders at individual schools and districts resulting in models that may not have

completely met their needs. The Model Schools Program, which is utilized in this study, has a more constructivist approach. Teams of teachers and administrators from participating schools design and implement their own mathematics and science reform plans with assistance from university faculty, acting as coaches for the school teams. More than half of the teachers and most of the principals on these teams participated in Ohio's systemic initiative (*Discovery).*

Background

Ohio Systemic Initiative

In the early 1990's, 25 states and the Commonwealth of Puerto Rico received substantial funding from the National Science Foundation to initiate systemic (SSI) reforms in mathematics and science education (Kahle, 1997). Systemic initiatives can be seen as a means of "providing top-down support for bottom-up instructional improvement in classrooms, schools, and districts" (Valencia & Wixson, 2000, p. 911). Ohio was one of the first SSIs funded and was known as Project *Discovery*. It spawned three Urban Systemic Initiatives (USIs: Cleveland, Columbus and Cincinnati) and part of the Appalachian Rural Systemic Initiative (RSI). Although Ohio's SSI was not funded by NSF for an additional five years, it secured continued state funding and continues to lead reform efforts in the state. In that important sense, the Ohio SSI has truly become systemic (Conway, Goodell & Carl, in press) with many current reforms located within districts and schools (Kahle & Damnjanovic, 1998; Kahle & Meece, 2000).

The early focus of *Discovery* was on teachers and principals as agents of change. Teachers attended six-week summer institutes where they experienced learning through inquiry and standards-based instruction while strengthening their content knowledge.

These teachers were assisted to apply what they learned in their classrooms through extensive follow-up from *Discovery* personnel, the establishment of peer-support networks, and the provision of classroom materials. Principals and administrators attended institutes that were designed to familiarize them with mathematics and science reform efforts and provide them with suggestions on how they could support these efforts in their school (Kahle, Meece & Scantlebury, 2000).

Research findings in this area demonstrate that individual teachers were effective change agents in their own classrooms. Students in classes taught by *Discovery*-trained teachers outperformed students in comparison classrooms (Kahle, Meece, & Scantlebury, 2000, Kahle & Meece, 2000). Other findings also revealed that principal institutes were effective in building administrators understanding of standards-based instruction (Kahle & Damnjanovic, 1998; Kahle & Boone, 1997).

Findings of recent research demonstrate that the greatest improvements in student achievement were evident in schools where greater than 50% of the teachers attended *Discovery* institutes and where district- and school-level policies were aligned with the focus of the SSI (Kahle & Damnjanovic, 1998; Kelly & Kahle, 2000). These findings provide the framework in which *Discovery* Model School Initiatives were founded upon.

Discovery Model School Initiative

Whole school, teacher led reform is the focus of the *Discovery* Model School Initiatives, which is now in its third year. The initiative had its beginning at the *Discovery* Center at Miami University in January 2000. At that time, a request for proposals to participate in the initiative was sent to schools. Five-person teams from six schools or districts were selected. A two-week summer institute was held. The reform framework

under which *Discovery* was established and maintained was presented and emphasized throughout the institute. By the end of the two weeks, teams had finalized their professional development plans that were to be implemented over the forthcoming school year. Mini-grants to support their plans were available. Plans had to show evidence of incorporating the *Discovery* framework discussed previously, as well as focus on the specific needs of their school and district. Each team had access to a university educator (dubbed coach) who worked with them in designing and revising their professional development plan throughout the year.

During year two, reform was extended to schools in the Northeast Ohio and Dayton areas. Summer institutes were held at John Carroll and Wright State Universities. In general, the design and focus of the institutes followed the format set up at the *Discovery* Center. Two additions to the original course design were made, however. At the Northeast institute, follow-up sessions were established which helped assist teachers with the writing and implementation of their reform plan. At the Wright State Institute, university coaches attended the summer institutes. They became key participants and advisers in the reform process at these schools. Teachers at Wright State schools were also granted monthly release time in which they worked through their professional development plan with their university coach and received university credit for participation.

Theoretical Framework

Standards-based teaching practices, quality professional development, equity, and effective leadership are the guiding principles for the Model School Initiative. The cornerstone of standards-based teaching is inquiry. It was strongly emphasized in the

Model School Institutes and extensively researched in the first two papers of this session. The National Research Council (NRC) (1996), defined inquiry as:

> a multifaceted process that involves making observations, posing questions, examining books and other resources for what is already known, planning investigations, reviewing what is known in light of experimental evidence, using tools to gather, analyze, and interpret data, proposing explanations, making predictions, and communicating results. Inquiry requires identification of assumption, use of critical thinking and consideration of alternative explanations. (p. 23).

The Model School Initiative utilizes Loucks-Horsely, Hewson, Love, and Stiles' (1998) *Developing Professional Developers* strategy to model successful professional development for the institute participants. This strategy assumes that local professional developers are highly committed to the success of their professional development plan, understand how to adapt the plan to fit local needs, and support others participation in the reform efforts outlined in the plan.

The development of teacher leadership has been a central theme in *Discovery's* efforts to improve math and science teaching and learning from its inception. Previously, teachers and principals attended separate institutes to encourage inquiry teaching, but in the Model Schools initiative, teachers and principals come together to design and implement a professional development plan for their school and/or district.

Distributed leadership through the development of trusting relationships is a necessary condition for change, replacing top-down management practices (Spillane, Halverson & Diamond, 2001). In the most effective teams, the administrator uses the authority of the position to create opportunities for teacher leadership through transformative leadership practices (Burns, 1978; Leithwood, Begley & Cousins, 1994). Unfortunately, this form of leadership is difficult to achieve because it requires a

negotiation of power among group members (Burns, 1978; Spillane, Halverson & Diamond, 2001).

Materials and Methods

This study investigates science and math whole school reform efforts at four schools in the Wright State Model Schools Initiative. Two middle schools, one high school and one elementary school participated in this study. Three of these schools are suburban schools located near Dayton, Ohio. The elementary school is an urban school. Table 1 provides demographic information for each school site.

The following research questions focused the study:

1. What is the pre-reform (baseline) state of the model schools?
2. What processes and approaches did teachers intend to use to reform mathematics and science education at each site?
3. What processes and approaches did teachers use to reform mathematics and science education at each site
4. Were there the significant changes in classroom practice and principal support during year one?

Both qualitative and quantitative data were used to answer these questions. Qualitative data were collected by a team of researchers. Fall and spring site visits were conducted at the Wright State schools. During the visits, demographic information was gathered. Classroom observations were made. Science teachers, math teachers, and team members were interviewed. Professional development plans were reviewed. Facilitators and barriers to Model School reform efforts were investigated.

A common protocol was established to guide the school visits and a synthesis sheet was generated to guide the writing of the case report for each school. Observations and interviews were cross-referenced to the synthesis sheet. All data was coded directly. The codes were used to develop core categories or themes. Similar themes were grouped

together to form major themes (Strauss & Corbin, 1990). The major themes generated are presented in this paper.

Quantitative data collection involved a pre-post test research design and consisted of teacher questionnaires that documented inquiry and standards-based teaching practices taking place in the science and mathematics classrooms prior to and following year one of the reform.

Bridging Teacher Questionnaires

The Bridging Teacher Questionnaire was originally developed to help assess the effectiveness of Ohio's Systemic Initiative. Item validity and reliability has been well established for the Bridging Teacher. Items were validated by a panel of mathematics and science education experts. Furthermore, the questionnaire was field-tested and used in schools similar to, but not part of this study (Kahle, 1997).

This study focused on the following Bridging Teacher Questionnaire Subscales: Classroom Use of Standards-Based Instruction and Principal Support for Standards-based Instruction. The Cronbach Alpha reliabilities for these factors were established at .84 and .86, respectively (Goodell, 1998; Kahle, 1997). Teachers' responses on both these factors ranged from *Strongly Agree* (5) to *Strongly Disagree* (1).

Questionnaire Administration and Return Rates

Bridging Teacher Questionnaires were administered to teachers during the Fall (October) of 2001 and the Spring (May) of 2002. Return rates for the questionnaires were very good for three of the four participating schools (Table 1). In contrast, the return rate for the elementary school was low (i.e., 32%). Therefore, questionnaire data collected from his school was not included in the study.

Pre-post comparisons were made between the three remaining schools. Comparisons were made between the two middle schools, as well as the middle school and high school participating from the same district.

Results

Qualitative Findings

During July 2001, teachers and administrators from one high school, two middle schools, and one elementary school attended a two-week Wright State University Model School Summer Institute. University coaches were paired with school teams. The coaches attended the Wright State University Summer Institute along with their team members.

The schools served middle to low-income communities. The student population at the high schools and both middle schools was predominately white. The student population at the elementary school was diverse; it comprised of 55% African American and 45% white students. Mathematics and science proficiency test scores were below the state average at all four schools (Table 2).

Research Question #1: What is the pre-reform (baseline) state of the model schools?

At the beginning of the year, traditional teaching strategies were observed at the high school. In contrast, standards-based teaching practices were prevalent in one of the middle school's mathematics and science classrooms. At the other middle school, teaching practices varied between mathematics and science classrooms. Traditional teaching practices were observed in mathematics classroom. Standards-based practices were observed in science classrooms. Hands-on, problem-solving activities were observed at the elementary schools.

Research Question #2: What processes and approaches did teachers intend to use to reform mathematics and science education at each site?

Overall, the model school team members at all four schools emphasized standards-based instruction in their reform plan. They planned to increase the frequency of these teaching practices at their schools. Curriculum alignment was central to reform efforts at the one middle school and at the elementary schools. At the high school and one of the middle schools, technology was emphasized also. The intended reform plans are outlined in Table 3.

Research Question 3: What processes and approaches did teachers use to reform mathematics and science education at each site and what factors facilitated or impeded implementation?

Mauve Middle School successfully implemented their year one plans without any trouble. This may be attributed to the strong collaborative environment present at this school. This was made possible because of monthly, whole day release times in which the team work together to design and implement inquiry-based teaching practices. This school also conducted peer observations in order for teachers to be able to observe inquiry at work in the classroom. The professional development activities they held were well attended. Changes in teaching practices were observed at the end of the year (Aaron Burke, WSU Spring Site Report, May, 2001).

Brown Junior High and Beige High School, which were both from the same district, conducted their professional development workshops together. These schools did run into a few road blocks. Middle school issues such as lack of administrative support and teacher buy-in as well as low institute attendance resulted in little overall

change in instruction. However, some mathematics teachers at the middle school began to incorporate inquiry instruction into their traditional classrooms (Aaron Burke, WSU Spring Site Report, May, 2001).

Beige High School encountered scheduling issues and lack of teacher buy-in as well. This resulted in few teachers (12 out of 23) implementing inquiry lessons in their classrooms. Stipends were given as incentives for teachers to use inquiry in their classrooms, but the lack of teacher buy-in seemed to pose a greater problem than originally anticipated. Nevertheless, inquiry instruction was witnessed in selected chemistry and general science classrooms at the high school (Aaron Burke, WSU Spring Site Report, May, 2001).

The efforts made at Orange Elementary School were not successful. The key goal - to hold workshops in which the teachers would learn how to create an inquiry-based lesson and curriculum for their professional development was never addressed. Budget and leadership issues, as well as other unforeseen barriers such as extensive illness of a key team member and early retirement by another member hindered progress at this site.

Research Question 4: Were there significant changes in classroom teaching practices or principal support during year one?

Changes in Teaching Practices. Quantitative findings indication that the middle and high schools teachers in the study increased their use of standards-based teaching practices after one year of teacher-led reform efforts (N=48, pre reform mean of 3.17 and post reform mean of 3.32, $t = -2.741$, $p = .009$).

Further analysis was performed collectively on Beige High School and Brown Junior High. These two schools participated jointly in the reform efforts and professional

development and were both in the same school district. Paired sample t-tests revealed that teachers at these two schools also increased their use of standards-based teaching practice after only one year of reform, (N=34, pre reform mean of 3.18 and post reform mean of 3.33, t = -2.347, p=.025).

A final pre-post comparison was performed on the two middle schools (i.e., Brown and Mauve) in the study. Once again, paired sample t-tests revealed that teachers at these two schools also increased their use of standards-based teaching practice after only one year of reform, N=27, pre reform mean of 3.23 and post reform mean of 3.41, t = -2.117, p= .044).

Changes in Principal Support.

In contrast, no significant changes in support for these practices was evident for the two high schools and one middle school in the study, (N=34, pre reform mean of 3.43 and post reform mean of 3.67, t = -1.894, p=.070). Furthermore, no significant change was evident for the Beige and Brown schools, N=27, pre reform mean of 3.40 and post reform mean of 3.70, t = -1.876, p=.174), or middle schools in the study, (N=48, pre reform mean of 3.51 and post reform mean of 3.63, t = -1.398, p= .065).

Discussion

The purpose of this study was to investigate whole school mathematics and science education reform efforts in partnership with university faculty. The four schools who participated in this study attended summer institutes and had release days throughout the year during which they worked with university coaches to develop and implement their professional development plans.

The schools involved in this reform effort were intended to be schools where standards-based practices were prevalent and where there was a critical mass of *Discovery* teachers ready to instigate change. Principal and district support was expected to be high for reform efforts in these schools.

Baseline quantitative results revealed limited use of standards-based practices by teachers at these schools. Principal support was found lacking at two schools.

Changes in Teaching Practices

Despite the lack of support for reform by principals and administration at two of the schools in the study, changes in teaching practices were evident during the first year of reform. Overall, the three schools that actively participated in the quantitative data collection (i.e., Brown, Beige, and Mauve) reported an increase in the use of standards-based teaching practices.

In addition, Brown Junior High and Beige High School, both from the same school district demonstrated, reported an increase in the use of standards-based teaching practices by the end of year one.

Change was evident in teaching practices at the middle school level in science as well. Both middle schools (Brown and Mauve) that participated in this study reported an increased use of standards-based teaching practices in their classrooms.

Principal support was not found to change in this first year of reform at any of the participating schools. In the case of the two schools from the same district, the lack of having a building administrator on the reform team may have created a lack of involvement overall on the part of the building administration. This demonstrates the need to involve key stakeholders in reform and change efforts.

Principal support at Mauve Middle School was good at the beginning of the year. The principal was a member of the team. Questionnaire results revealed that the support from the administrator at this school did not change, it was high at the beginning of the initiative and remained steady throughout the year.

Possible Reasons for Individual School Successes

All three schools that participated in this initiative were involved with, not only summer institutes, but also sustained professional development that was organized into monthly release time. During these release times, teachers were given between one half and one full day to reflect upon what they were doing in the classroom. During these time team members and teachers in the building discussed their experiences. Additional professional development opportunities were developed.

The sustained professional development format experienced by the teachers in this study appeared critical for their success. This finding is well supported by the literature. Researchers have argued that sustained professional development is necessary to promote changes in pedagogical preparedness of teachers (Guskey, 2000; Loucks-Horsley, Hewson, Love, & Stiles, 1998; Supovits & Turner, 2000).

In addition, Supovitz and Turner (2000) have argued that 80 hours of sustained professional development was required to promote changes in teachers' preparedness to use inquiry teaching practices and authentic assessment strategies. The schools involved in this study have logged between 35-70 hours of professional development in the first year. The sustained professional development experienced by teachers at these schools began to yield significant change in classroom teaching practices by the end of year one.

A comment on whole- school reform is also in order. Desimone, L.M., Porter, A.C., Garet, M.S., Yoon, K.S., and Birman, B.F. (2002) have argued that, "collective participation of groups of teachers from the same school, department, or grade level" should be the focus of professional development, "as opposed to the participation of individual teachers from many schools" (p.83). That focus was evident in this study and may have contributed to the success of the reform.

In conclusion, professional development experiences should build upon prior understanding and readiness for reform. It should also incorporate new understandings through active engagement in new collaborative experiences. Quality professional development takes time and administrative support is important. (Kahle, 1997; Loucks-Horsley et. al, 1998).

Limitations of Study

The primary limitation of this study is that it has been carried on for only one year. Success of a reform effort can seldom be determined by changes that have taken place during the first year of the initiative. Year one of any reform is a trial period both from the professional development and evaluation perspective. Extended data collection will help explain and expand both these perspectives. In terms of professional development, it will be important to determine if the effectiveness of the sustained format used by teachers in this study is maintained. Will the effectiveness of the reform increase steadily or go through cyclic declines and increases?

In terms of the evaluation of the reform, it will be important to broaden both the qualitative and quantitative data collection to include students. Student account of reform

efforts at their schools must be documented and compared with those reported by their teachers. Student achievement must be monitored.

Conclusion

The current research base on whole school reform efforts is limited (Keltner, 1998). In addition, published findings of reform efforts led by teacher teams are minimal. This study offers findings that indicate significant change can take place in classroom teaching practices through teacher-led reform. However, sustained professional development is needed. Also the professional development must be held within a collaborative context using university faculty as coaches, team members, and stakeholders in the reform.

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Table 1: Return rate for teacher questionnaires by school

School	**# of teachers participating**	**# of returned quesionnaires**	**Return Rate**
Beige High School	23	21	91%
Brown Junior High	16	14	88%
Mauve Middle School	15	13	87%
Orange Elementary	25	8	32%

Table 2. Demographic Information for All Model School Sites Observed

	Beige High School	Brown Junior High	Mauve Middle School	Orange Wright Elementary
Enrollment	1,640	930	850	560
Student Ethnicity (%) (1998-EMIS)				
White	90%	90%	90%	55%
African-American, Asian and Indian	10%	10%	10%	45%
% Free or Reduced Lunch	15%	15%		100%
Math Ohio Proficiency Test 1998	9th grade test 57.4%			
Math Ohio Proficiency Test 1999	9th grade test 60.1%			
Math Ohio Proficiency Test 2000	9th grade test 59.7%	Off grade (7th/8th) test 70%	6th grade test 53%	4th grade test 13.3%, 6th grade test 6.6%
Science Ohio Proficiency Test 1998	9th grade test 65.5%			
Science Ohio Proficiency Test 1999	9th grade test 70.8%			
Science Ohio Proficiency Test 2001	9th grade test 71.2%	Off grade (7th/8th) test 70%	6th grade test 53.7%	4th grade test 13.3%, 6th grade test 18%

Table 3: Baseline Plans for Professional Development and Actual Professional Development

School	Baseline Instructional Practices	Implemented Professional Development/Goals Year One	Professional Development/Goals That Were Not Implemented	Reasons for Change in Plan
Beige HS	Traditional teaching practices with attempt to use inquiry in advanced classes	All teachers participated in at least some of the activities and many experimented with using inquiry in their classrooms, 80% participated in support group, some worked together to develop inquiry lessons	Only 6 teachers met goal of teaching four inquiry lessons throughout the year, only one of four support group meetings was conducted	Lack of teacher buy-in and accountability, scheduling problems
Brown JH	Standards based instruction in both math and science was prevalent	All of math and science teachers participated in some activities and were made aware of inquiry-based teaching, 12 of 16 participated in institute activities, experimented with inquiry in their classrooms and reflected in study groups monthly	Building administrators were not part of team, only one teacher of six participated in summer institute	Lack of administrative support, lack of teacher interest/accountability
Mauve MS	Math instruction was traditional, science instruction included some standards based	Establish Weisenborn Inquiry Teaching Support System, partnerships with peer teachers, examine math/science inquiry case studies, attend inquiry-based training sessions, develop curriculum and implement, peer observations	Peer observations were conducted, but frequency and documentation were weak	No structured form for observations
Orange	Hands-on problem solving	Initial staff meeting/overview of Model Schools, staff trip to COSI, 1 workshop at WSU, math and science night, WSU students taught inquiry lessons in selected classrooms, WSU science fair judges.	Staff meeting/case discussion, workshop on how to create inquiry-based lessons, study groups, retreat on inquiry-based curriculum, school standards/curriculum alignment team quarterly meetings.	Budget and leadership issues, lack of teacher buy-in.

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